COUNTRY-SPECIFIC DETERMINANTS OF INTRA-INDUSTRY TRADE IN PHARMACEUTICALS: THE CASE OF POLAND AND ITS EUROPEAN UNION PARTNERS

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Introduction

Pharmaceuticals are chemical and biological substances produced by the pharmaceutical industry, used in therapies and prevention of various diseases. They cover an extremely wide range of products, ranging from simple medicinal preparations, to extremely advanced technological specifics. Similar to food, pharmaceutical products are believed to be one of the most important needs of human beings. They have a significant impact on their health, often support and extend their lives. Due to their specific properties and healthcare function of pharmaceuticals, they are contained in the category of basic products and their significance is appreciated not only by buyers (patients) but also by authorities in most countries. That is why in many countries special attention is paid to the development of production and trade in pharmaceutical products. The special importance of the pharmaceutical industry was also emphasized in a European Commission document, which indicated that it is a strategic branch of Europe's industry (European Commission, 2014).

The important role of international trade in pharmaceutical products is the resultant of many factors determining the situation on the global pharmaceutical market. The major factors include as follows:

- restrictive legal provisions; they concern every stage of the production and distribution chain, from the synthesis of active substances to the dispensing of the drug to the patient;
- limited possibility of transferring unique technologies within the pharmaceutical sector, resulting mainly from huge costs; the development and implementation of new effective medicines for production is not only very costly but also time-consuming;
- patent protection of many pharmaceutical products; global pharmaceutical concerns effectively protect their production, making it impossible for other producers with generic equivalents of patented drugs to enter the market;
- aging societies and an increase in the problem of civilization diseases, especially in developed countries and the related increase in the demand for medicines and medical products.

The largest part of world trade is intra-industry trade. It occurs when countries simultaneously export and import products belonging to the same industry branch (commodity group). It develops particularly well in industrialized countries in the scope of processed products, especially those that are available in many versions or variants (Łapińska, 2016; Cieślik & Wincenciak, 2018). This category also includes medicines and other products delivered to the market by the pharmaceutical industry. Many factors determine the commencing and intensity of intra-industry trade. The creators of theoretical models of intra-industry trade perceive the reasons for the development of this type of exchange in the existence of a specific, usually imperfectly competitive market structure, where various types of products are traded. The nature of the production technique used is also significant, characterized by increasing economies of scale. However, the diversity of products and the presence of economies of

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scale are only a prerequisite for the emergence of intra-industry trade flows. A range of factors determines whether intra-industry trade between countries will be initiated and then developed. These factors reflect the specifics of trading countries and characteristics of markets, products and industries (branches) in which the exchange takes place.

The existing subject literature lacks empirical findings on the factors determining intra-industry trade in pharmaceutical products, especially in European Union trade. The few publications on the determinants of intra-industry trade in this extremely important group of products concern the Middle East countries (see Yusefzadeh et al., 2015; Aghlmand et al., 2018). Therefore, this study is an attempt to fill part of the existing research gap in this area.

The purpose of this study is to identify the country-specific determinants impacting the intensity of intra-industry trade within Poland's trade turnover with European Union countries in pharmaceutical products.

1. Country-Specific Determinants of Intra-Industry Trade – Literature Review

The specificity of intra-industry trade means that so far it has not been possible to develop one model that would explain the existence of all streams of this type of exchange. This results in some difficulties in identifying the factors determining the development of intra-industry trade. Individual models (see e.g., Krugman, 1979; Brander, 1981; Davis, 1995) explain the existence of only some specific intra-industry trade streams. Depending on the adopted assumptions of the model construction (e.g., the structure of the market on which the exchange is being carried out, the type of goods being subject to exchange), different conclusions can be drawn as to the prospects for the development of two-way trade. It causes that the set of determinants of intra-industry trade, referring both to the characteristics of economies participating in the exchange, and to the characteristics of industries and products subject to exchange is quite wide. Among the researchers of intra-industry trade, there is, however, a greater consensus on macroeconomic determinants of the development of intra-industry trade, i.e., country-specific determinants rather than industry-specific determinants.

Previous theoretical and empirical studies confirm that the determinant that is conducive to the development of intra-industry trade is the high level of gross domestic product *per capita*. The impact of GDP *per capita* on the intensity of intra-industry trade can be interpreted in two ways – from the supply and demand sides (Czarny, 2002). First of all, highly developed economies are characterized by a higher level of innovation and have a better developed processing industry. This facilitates the introduction and development of the production of substitute goods with a significant degree of differentiation, which, in turn, facilitates the development of two-way trade. Secondly, high income consumers are more likely to buy diversified, highly processed products which, in turn, facilitate the development of the exchange of similar products belonging to the same branch. The importance of high GDP *per capita* in increasing the intensity of intra-industry trade is also confirmed by Thorpe and Zhang (2005), Dalgin (2010), Phan and Jeong (2014).

Small differences between GDP *per capita* of trading countries constitute another factor supporting the development of intra-industry trade. They can be indicative of similar consumer preferences of buyers from both countries. Such an interpretation refers to the concept of similarity created by Linder (1961), according to which the intensity and structure of trade depend mainly on the degree of similarity between countries. The importance of this determinant in increasing the intensity of intra-industry exchange is confirmed by Loertscher and Wolter (1980), Thorpe and Zhang (2005), Łapińska (2014).

A significant factor determining the intensity of intra-industry trade is the size of economies that trade with each other. They are usually measured by the size of their GDP. The size of economies is recognized as a key determinant in the development of turnover in the gravity models of trade (see, for example, Anderson, 1979; Bergstrand, 1985; Pietrzak & Łapińska, 2014, 2015; Cieślik & Michałek, 2018; Szczepaniak, 2018). The bigger the trading partners' economies, the more intensive trade exchange, including intra-industry trade. This is confirmed by numerous empirical studies (see, for instance: Caetano & Galego, 2007; Onogwu, 2013; Jámbor, 2014; Aghlmand et al., 2018).

The size of the economy is related to the possibility of developing production

characterized by increasing economies of scale, which in the light of the theory of intra-industry trade are one of the key determinants encouraging countries to specialize in intra-industry and two-way trade. The size of GDP is also considered to be a measure of the development of production of diverse goods and an important factor affecting the level of international competitiveness of countries (Cheba & Szopik-Depczyńska, 2017). Higher GDP is then tantamount to having a large capital stock and developed financial markets, which provide financial support for capital-intensive, technologically advanced industries (Kocmanová, Dohnal, & Meluzín, 2011; Meluzín & Zinecker, 2014; Meluzín et al., 2017). This, in turn, enables the development of the processing industry manufacturing diverse goods.

The factor supporting the development of intra-industry trade is also small differences in the size of the trading countries' economies, expressed as the differences in the levels of GDP of trading partners. This determinant is related to Helpman's theorem (1987), which showed that bilateral trade between countries is directly proportional to the product of their gross domestic products. He confirmed the truth of his claim with reference to highly developed countries. Empirical tests of Helpman's theorem were also carried out by other researchers (see, for example, Hummels & Levinsohn, 1995; Okubo, 2007). The results obtained by them indicate the existence of a negative correlation between intra-industry trade and large differences in the size of countries that trade with each other. There are, however, some empirical studies that do not confirm this relationship. According to Markusen and Vanables (1996), comparable sizes of economies are not necessarily conducive to the development of intra-industry trade. Under certain conditions, intra-industry trade may be replaced by mutual direct investments (Fukao, Ishido, & Ito, 2003; Nazarczuk & Umiński, 2018).

Other factors determining the level of intra-industry trade between countries is a large share of goods processed in mutual trade and a significant intensity of trade contacts between trading partners. Ekanayake (2001) and Łapińska (2016) show that they significantly support the development of intra-industry trade. Empirical research (see, for instance, Leitão, 2011; Łapińska, 2014) also shows that imbalance of trading countries' trade balance has an adverse effect on the intensity of intra-industry trade. If trade exchange between two countries is not balanced, then the intensity of intra-industry trade cannot reach the maximum value.

A factor significantly affecting the degree of intensity of trade between countries is also the geographical distance that separates the trading partners. A considerable distance between two trading countries results in an increase in transaction costs, mainly due to the cost of transport and insurance of goods. It is therefore a factor limiting the development of trade, including intra-industry trade (Leitão & Shahbaz, 2012; Phan & Jeong, 2014; Łapińska, 2016).

The factor supporting the development of intra-industry trade related to geographical proximity is having a common border with a trading partner (Ekanayake, 2001). This dependence is mainly due to the possibility of using the advantages related to the location of production. The intensification of intra-industry trade is also strengthened by cultural community, similar language, historical and political ties (Czarny, 2002). However, Matthews (1998) argues that these factors lose their importance as the economic integration progresses.

Intra-industry trade becomes more intense where economies begin to open up. The most common measure of the protection of the internal market in this context is the nominal level of customs duties. The negative relationship between the size of trade barriers and the intensity of intra-industry trade was first noticed by Balassa (1966). The existence of this dependence was confirmed later in other studies carried out by, for instance, Bergstrand (1990), Sharma (2004), Foster and Stehrer (2011), and Łapińska (2015). The opening of economies is connected with another important factor supporting intra-industry trade, namely integration processes. The importance of economic integration in increasing the intensity of intra-industry trade is associated not only with the reduction of restrictions on trade but is also due to the fact that the integration group usually includes countries with a similar level of economic development. The results of empirical research (see, among others: Sharma, 2004; Wakasugi, 2007; Foster & Stehrer, 2011; Łapińska, 2015) prove that in the conditions

of imperfections of competition and product differentiation, integration processes favour the development of intra-industry trade.

In empirical studies, attempts are made to verify other factors, such as, for example, foreign direct investment (Xing, 2007; Ambroziak, 2016). The impact of FDI on the development of intra-industry trade can be positive, providing it contributes to the modernization of the economy, industrial development and the production of diverse goods, or negative, if it is a substitute for trade with foreign countries.

2. Intensity of Intra-Industry Trade in Pharmaceuticals between Poland and European Union Countries

In most cases, the Grubel-Lloyd index is used in empirical research to measure the intensity of intra-industry trade and it is calculated according to the following formula (Grubel & Lloyd, 1975):

$$GL_i = \frac{(X_i+M_i)-|X_i-M_i|}{(X_i+M_i)} = 1 - \frac{|X_i-M_i|}{(X_i+M_i)} \quad (1)$$

where X_i – the value of exports of the industry *i*; M_i – the value of imports of the industry *i.*

The above indicator takes values from the interval [0;1]. The higher the GL_i indicator value, the more intense intra-industry trade. The maximum value is achieved if the turnover of a given industry (branch) is balanced ($X_i = M_i$); Then, the entire trade volume within this branch is intra-industry like. If, however, branches do not export or import goods at all ($X_i = 0$ or $M_i = 0$), the GL_i index takes the value equal to zero, which means that no intra-industry trade occurs.

Examining the intensity of intra-industry trade with a specific trading partner requires the use of a bilateral index:

$$GL_{ij} = \frac{(X_{ij}+M_{ij})-|X_{ij}-M_{ij}|}{(X_{ij}+M_{ij})} = \\ = 1 - \frac{|X_{ij}-M_{ij}|}{(X_{ij}+M_{ij})}, \quad (2)$$

where X_{ij} – the value of exports to the country of the trading partner *j* of goods belonging to the industry *i;* M_{ij} – the value of imports to the country of the trading partner *j* of goods belonging to the industry *i.*

An aggregated measure that shows the intensity of intra-industry trade in all countries or a group of countries is obtained by calculating the weighted average value of indices for individual countries (GL_{ij}). The weights of each of the countries in total turnover in specific goods or groups of goods are considered to be weights.

Intensity indicators for Poland's intra-industry trade in pharmaceutical products with individual EU countries in 2004-2016 are presented in Tab. 1. They were calculated for three-digit groups of goods separated according to the Standard International Trade Classification. The groups were: 541 – medicinal and pharmaceutical products (other than medicaments of group 542) and 542 – medicaments (including veterinary medicaments). The presented data show that in the years 2004-2016 there was an increase in the intensity of intra-industry trade in pharmaceuticals with the majority of EU countries. The intra-industry trade with countries that were members of the Community before its enlargement in 2004 (EU-15) was particularly well developed.

The greatest increase in the intensity of intra-industry trade was recorded in trade with Denmark. In 2004, Polish-Danish intra-industry trade in pharmaceutical products practically did not exist, the Grubel-Lloyd index was only 0.034. However, in the last year covered by the analysis, intra-industry trade was already the dominant form of trade with Denmark (GL_{DK} = 0.883). A significant increase in the intra-industry trade index was also recorded in trade with Portugal, Spain, and Italy (see Tab. 1). In the case of several trading partners, the two-way trade intensity indices decreased over the period considered. However, these countries did not belong to the group of Poland's most important EU trade partners in pharmaceutical products. In 2016, their share in Poland's trade in pharmaceutical products amounted only 6.2%, which did not significantly affect the development of the aggregate Grubel-Lloyd index for pharmaceuticals, which increased from 0.125, in 2004 to 0.417, in 2016 (see Fig. 1).

In order to identify the factors, which determine Poland's intra-industry trade with European Union countries, an econometric model for panel data was constructed. The values of the bilateral Grubel-Lloyd index were assumed to be the explained variable.

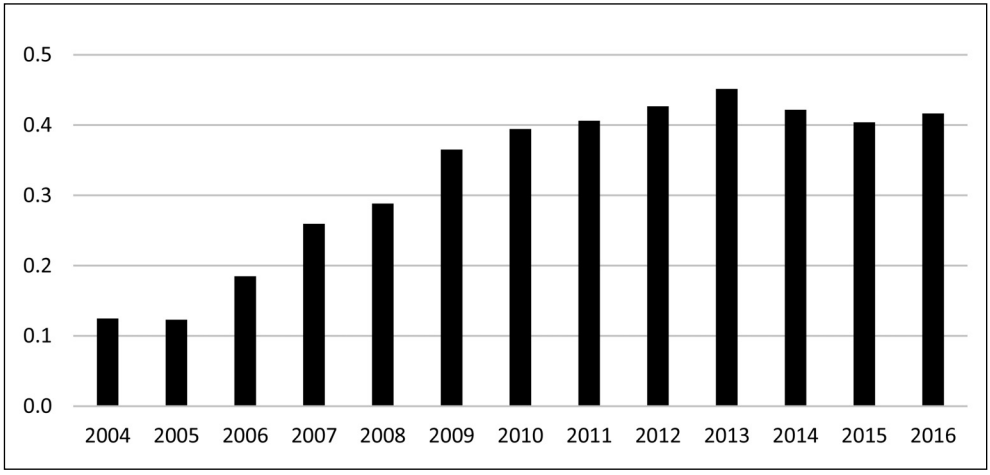
Tab. 1: Intensity of intra-industry trade between Poland and European Union countries in pharmaceutical products in the years 2004-2016

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	0.004	0.010	0.234	0.139	0.154	0.277	0.255	0.204	0.200	0.109	0.086	0.123	0.128
Belgium	0.003	0.004	0.013	0.018	0.005	0.021	0.045	0.034	0.034	0.062	0.090	0.105	0.131
Bulgaria	0.636	0.174	0.095	0.281	0.108	0.183	0.270	0.603	0.786	0.949	0.850	0.883	0.674
Croatia	0.514	0.375	0.549	0.733	0.957	0.942	0.387	0.314	0.605	0.380	0.681	0.573	0.616
Cyprus	0.758	0.129	0.804	0.016	0.090	0.619	0.626	0.618	0.862	0.900	0.268	0.113	0.092
Czech Republic	0.717	0.616	0.519	0.628	0.672	0.792	0.597	0.620	0.550	0.578	0.606	0.588	0.700
Denmark	0.034	0.082	0.141	0.181	0.233	0.392	0.524	0.482	0.618	0.745	0.537	0.750	0.883
Estonia	0.228	0.148	0.071	0.181	0.015	0.004	0.047	0.011	0.012	0.003	0.005	0.010	0.008
Finland	0.952	0.300	0.329	0.247	0.661	0.929	0.680	0.796	0.371	0.312	0.337	0.447	0.515
France	0.049	0.040	0.059	0.151	0.237	0.311	0.369	0.369	0.593	0.536	0.602	0.573	0.386
Germany	0.164	0.130	0.218	0.338	0.369	0.462	0.525	0.535	0.546	0.566	0.473	0.417	0.489
Greece	0.046	0.020	0.532	0.762	0.858	0.763	0.871	0.837	0.809	0.635	0.466	0.234	0.182
Hungary	0.366	0.442	0.654	0.606	0.622	0.699	0.495	0.293	0.341	0.579	0.594	0.531	0.444
Ireland	0.000	0.001	0.006	0.074	0.102	0.100	0.114	0.118	0.162	0.092	0.090	0.110	0.065
Italy	0.239	0.160	0.269	0.439	0.490	0.733	0.839	0.840	0.779	0.796	0.793	0.854	0.832
Latvia	0.419	0.213	0.137	0.090	0.120	0.167	0.089	0.191	0.112	0.066	0.154	0.174	0.227
Lithuania	0.032	0.013	0.005	0.030	0.060	0.077	0.114	0.187	0.087	0.307	0.360	0.290	0.394
Luxembourg	0.005	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.005	0.001	0.010	0.061	0.128
Malta	0.000	0.062	0.217	0.036	0.073	0.285	0.272	0.158	0.284	0.372	0.136	0.081	0.109
Netherlands	0.017	0.028	0.018	0.026	0.067	0.046	0.081	0.107	0.136	0.183	0.156	0.123	0.097
Portugal	0.054	0.225	0.232	0.794	0.448	0.143	0189	0.293	0.364	0.398	0.565	0.680	0.772
Romania	0.793	0.858	0.642	0.648	0.431	0.574	0.589	0.641	0.715	0.890	0.889	0.876	0.672
Slovakia	0.341	0.741	0.902	0.841	0.632	0.627	0.456	0.473	0.714	0.651	0.293	0.298	0.269
Slovenia	0.025	0.117	0.132	0.113	0.169	0.281	0.217	0.375	0.325	0.302	0.334	0.324	0.329
Spain	0.058	0.113	0.194	0.376	0.541	0.776	0.715	0.763	0.613	0.825	0.452	0.385	0.717
Sweden	0.017	0.137	0.171	0.842	0.360	0.436	0.361	0.694	0.464	0.188	0.229	0.245	0.299
United Kingdom	0.092	0.105	0.208	0.359	0.334	0.393	0.432	0.464	0.441	0.448	0.652	0.651	0.603

Source: own calculations based on the Eurostat (2018)

Due to the fact that the explained variable takes values from the interval [0;1] the logit transformation of the explanatory variable GL_{jt} has been performed. The dependent variable was obtained in the form of logit $\ln[GL_{jt}/(1-GL_{jt})]$, whose values belong to the range $(-\infty;\infty)$. Thus, the possibility of obtaining the theoretical values of the GL_{jt} index that exceed the allowed range [0;1] was eliminated. The indices of intra-industry trade were calculated for Poland's trade with individual EU countries, in the years 2004-2016, for three-digit product groups separated according to the Standard International Trade Classification. These groups were: 541 – medicinal and pharmaceutical products (other than medicaments of group 542) and 542 – medicaments (including veterinary medicaments). The study included 27 Polish trade partners who were members of the European Union in 2016. In order not to eliminate countries for which no intra-industry trade occurred in individual years, the procedure proposed by Lee and Lee (1993) was applied. It is based on the assumption that the explained variable (the Grubel-Lloyd index) instead of the value 0, takes a very small value equal to 0.0000001 and on substitution of this value for logarithmic purposes.

Fig. 1: **Intensity of intra-industry trade between Poland and European Union in pharmaceutical products in the years 2004-2016 calculated based on the Grubel-Lloyd aggregate index**



Source: own calculations based on the Eurostat (2018)

3. Theoretical Hypotheses

Based on theoretical literature and the results of previous empirical studies on country-specific determinants of intra-industry trade, some research hypotheses (H1-H8) have been formulated below. They focus on the characteristics of the economies of countries that are Poland's trading partners within the European Union. Due to the specificity of goods being subject to exchange, which in this case are pharmaceutical products, it was decided to formulate one hypothesis more (i.e., H9). The hypothesis H9 is not directly derived from the theory of intra-industry trade, however, in the context of the considerations regarding trade in pharmaceuticals, it seems to be justified. It concerns the category describing general government expenditure on health. It was assumed that this category of government spending significantly influences the intensity of intra-industry trade in pharmaceutical products.

The following research hypotheses concerning the intensity of intra-industry trade in pharmaceutical products between Poland and EU countries have been verified:

H1: The size of the economies of Poland's trade partners, measured by the size of their GDP, has a positive effect on the intensity of intra-industry trade with these partners in pharmaceutical products.

H2: There is a negative relationship between the relative differences in the size of the Polish economy and its trading partners' economies (measured by the size of GDP) and the intensity of intra-industry trade in pharmaceutical industry.

H3: The level of economic development of trade partners, measured by their GDP per capita, is positively correlated with the intensity of intra-industry trade with these partners in pharmaceutical products.

H4: There is a negative dependence between the relative differences in the level of economic development of Poland and its trading partners (measured by the size of GDP per capita) and the intensity of mutual intra-industry trade in pharmaceutical products.

H5: The intensity of intra-industry trade in Poland's bilateral trade in pharmaceutical products is positively correlated with the intensity of trade between the countries, measured by the share of the trading partner in Poland's trade in pharmaceutical industry products.

H6: The level of imbalance in Poland's bilateral trade in pharmaceutical products

weakens the intensity of intra-industry trade in this kind of goods.

H7: There is a negative dependence between the geographical distance that separates trading partners and the intensity of their intra-industry trade.

H8: There is a positive dependence between the fact of having a common border with a trading partner and the intensity of intra-industry trade in pharmaceutical products.

H9: The size of general government expenditure on health incurred in trade partner countries has a positive impact on the intensity of intra-industry trade in pharmaceutical products between these partners.

The research hypotheses allowed model specification for panel data:

$$\begin{aligned}\ln[GL_{jt}/(1-GL_{jt})] &= \alpha_0 + \\ &+ \alpha_1 lnGDP_{jt} + \alpha_2 lnDiffGDP_{jt} + \\ &+ \alpha_3 lnPCI_{jt} + \alpha_4 lnDiffPCI_{jt} + \\ &+ \alpha_5 lnTI_{jt} + \alpha_6 lnTIMB_{jt} + \\ &+ \alpha_7 lnDIST_j + \alpha_8 BOR_j + \\ &+ \alpha_9 lnHEALTH_{jt} + v_{jt}\end{aligned} \quad (3)$$

$$v_{jt} = e_t + u_j + \varepsilon_{jt} \quad (4)$$

The description of individual variables and the sources of data used are presented in Tab. 2.

4. Model Estimation

Estimation of the panel data model, defined by the formula (3), was made using the *Gretl* programme (*GNU Regression Econometrics Time-Series Library version 9.1.14.*). Both the occurrence and significance of individual effects, as well as the nature of individual effects themselves (fixed or random) were not assumed *a priori.* The choice of the estimation method (*pooled OLS, fixed effects, random effects*) was made using the decision procedure proposed in the econometrics literature (see, among others Baltagi, 2001). Models with fixed and random effects were assessed and diagnostic tests were carried out. The results of the diagnostic tests are presented in Tab. 3.

Based on the diagnostic tests carried out, it was found that an appropriate model for studying the impact of macroeconomic determinants on the intensity of intra-industry trade is the fixed effects model (FE). Thus, the parameters of the fixed effects model

Tab. 2: The variables used in empirical investigation (Part 1)

Variables	Description of variables
GL_{jt}	Intensity of intra-industry trade between Poland and the country *j* in the year *t*, measured by the Grubel-Lloyd index. Data source: Eurostat (2018), code: DS-018995.
GDP_{jt}	Gross Domestic Product of the partner country *j*, in the year *t.* Data source: Eurostat (2018), code: nama_10_gdp.
$DiffGDP_{jt}$	The index of the relative difference in the size of Poland's GDP and the trading partner *j*, in the year *t.* The index values are determined by means of the following formula (Zhang & Li, 2006): $DiffGDP_{jt} = 1 + \frac{[wlnw+(1-w)ln(1-w)]}{ln2}$, (5) $w = \frac{GDP_{PLt}}{GDP_{PLt}+GDP_{jt}}$ (6) where: GDP_{PLt}, GDP_{jt} – gross domestic product of Poland and its trading partner *j* in the year *t.* The above index takes values from the interval [0;1]. If the differences in GDP between countries are large, then the index approaches the value of 1. With the same GDP of both countries, the value is 0. Data source: Eurostat (2018), code: nama_10_gdp.

Tab. 2: The variables used in empirical investigation (Part 2)

PCI_{jt}	The variable representing the level of economic development of the trading partner *j*, in the year *t*, expressed as GDP *per capita*. Data source: Eurostat (2018), code: nama_10_pc.
$DiffPCI_{jt}$	The variable representing the distance in the level of economic development that divides Poland and its trading partner *j*, in the year *t*. The values of the index are measured using the following formula (Zhang & Li, 2006): $$DiffPCI_{jt} = 1 + \frac{[wlnw+(1-w)ln(1-w)]}{ln2}, \quad (7)$$ $$w = \frac{PCI_{PLt}}{PCI_{PLt}+PCI_{jt}} \quad (8)$$ where: PCI_{PLt}, PCI_{jt} – GDP *per capita* of Poland and its trading partner *j*, in the year *t.* The above index takes values from the interval [0;1]. If the differences in *per capita* income between countries are high, then the index approaches 1. With the same GDP *per capita* of both countries, the value is 0. Data source: Eurostat (2018), code: nama_10_pc.
TI_{jt}	The share of the country *j* in Poland's trade in pharmaceutical products, in the year *t.* Data source: Eurostat (2018), code: DS-018995.
$TIMB_{jt}$	The degree of imbalance in trade between Poland and the country *j*, in the year *t*. The variable is determined according to the below formula: $$TIMB_{jt} = \frac{\lvert X_{jt}-M_{jt}\rvert}{(X_{jt}+M_{jt})}, \quad (9)$$ where: X_{jt} – Polish exports to the country *j*, in the year *t*, M_{jt} – Polish imports to the country *j*, in the year *t*. The $TIMB_{jt}$ variable takes the value of 0, if the trade between Poland and its trading partner, in the year *t*, is balanced ($X_{jt} = M_{jt}$) and takes the value of 1, if in one of the countries, its exports or imports (but not both exports and imports at the same time) is equal to 0. Data source: Eurostat (2018), code: DS-018995.
$DIST_j$	Geographical distance, measured in kilometres, between the capital cities of Poland and its trading partner *j*. Data source: Centre D'Etudes Prospectives et D'Informations Internationales (2018).
BOR_j	Dummy variable, takes the value of 1, if Poland has a common border with a trading partner *j* and the value of 0, if it does not border with the trading partner *j*.
$HEALTH_{jt}$	General government expenditure on health incurred by the country of the trade partner *j*, in the year *t.* Data source: Eurostat (2018), code: gov_10a_exp_COFOG_GF07.
v_{jt}	Random error in the object *j*, in the time period *t*, which consists of the following components: e_t – impulses affecting all observations in the period *t*, u_j – impulses affecting all observations in the object *j,* ε_{jt} – impulses affecting only observations in the object *j,* in the period *t*.

Source: own

Tab. 3: Test statistics and significance levels in the diagnostic tests of the model of intra-industry trade in pharmaceuticals between Poland and EU countries

Diagnostic test	Test statistic	p-value
Wald test	F = 8.46793	< 0.00001
Breusch-Pagan test	LM = 156.423	< 0.00001
Hausman test	H = 25.3214	< 0.00001

Source: own calculation

were estimated. However, a phenomenon of heteroscedasticity occurred, i.e. heterogeneity of variances of random components within the sample. Heteroscedasticity affects the incorrect estimation of standard errors for individual parameters and overestimation of the determination coefficient, which may distort the conclusions drawn on the significance of variables. Therefore, ultimately, the Weighted Least Squares (WLS) method was used to estimate the parameters, where the weights were the inverse of the elements from the variance of random components estimated for individual units in the panel.

5. Results of Estimation and Discussion of Findings

Values of statistically significant parameters of the model described by the formula (3) are presented in Tab. 4.

The model is correct in statistical terms. Five of the nine potential explanatory variables turned out to be significant. The general performance of the model is satisfactory (Adjusted R^2 = 0.693769).

When interpreting the results obtained, you can use the following interpretation method in relation to the variables that were previously logarithmized: an increase in the explanatory variable by 1% causes, *ceteris*

Tab. 4: The results of estimation of the model describing the determinants of intra-industry trade in pharmaceuticals

Dependent variable $\ln[GL_{jt}/(1-GL_{jt})]$					
Independent variables	**Coefficient**	**Std. Error**	**t-ratio**	**p-value**	**Significance**
Constant	2.9795100	1.0755700	2.770	0.00590	***
PCI_{jt}	-0.6340501	0.1238950	-5.118	<0.00001	***
$DiffPCI_{jt}$	-0.0359025	0.0158606	-2.264	0.02420	**
TI_{jt}	0.1717640	0.0534901	3.211	0.00140	***
$TIMB_{jt}$	-1.7156300	0.0751459	-22.830	<0.00001	***
$HEALTH_{jt}$	0.2079440	0.0562981	3.694	0.00030	***
Observations		351			
Standard error of residuals		0.902791			
R^2		0.698143			
Adjusted R^2		0.693769			
F (5, 345) = 159.5853		*p-value* for test F < 0.00001			

Source: own calculations

Note: ** Statistically significant at 5%, *** significant at 1%

paribus, an increase or decrease (depending on the sign of the parameter) of the explained variable by α% (a parameter located at a given variable explanatory). In this case, the logit is the explained variable, which means that the relation $GL_{jt}/(1-GL_{jt})$, which is the index of intra-industry trade (GL_{jt}) and inter-industry trade ($1-GL_{jt}$) changes by α%.

The size of GDP *per capita* achieved in the countries of Poland's trading partners turned out to be a variable that significantly and negatively impacts the intensity of intra-industry trade. This variable represents the level of economic development of individual countries. The research carried out shows that, on average, GDP growth *per capita* in trading partners' countries by 1% causes a decrease that is less than proportional (by about 0.6%) in the ratio of intra-industry to inter-industry trade in pharmaceutical products. The results obtained with regard to this variable – this is the direction of the impact, do not confirm the predictions of the theory of intra-industry trade, according to which higher *per capita* income facilitates intense intra-industry exchange (see hypothesis H3). Therefore, it is worth making an attempt to explain this relationship in the context of trade in pharmaceutical products.

In the theory of intra-industry trade, the impact of the GDP *per capita* variable on the intensity of intra-industry trade is considered on the demand and supply side (Czarny, 2002). In the first case, it is indicated that along with the increase in consumer incomes, their willingness to purchase differentiated products increases, they often buy many variants of varied goods or are willing to pay more for the preferred option, best suited to their expectations. This behaviour of consumers, *i.e.,* the demand for goods differentiated at the aggregate level, facilitates the development of intra-industry trade. It is worth noting, however, that pharmaceutical products are specific goods purchased by consumers in strictly defined situations resulting from the needs of protecting their health or even lives.

Therefore, in this particular situation, the result obtained (the negative impact of the PCI_{jt} variable on the intensity of intra-industry turnover of pharmaceutical products) may be justified. In the case of pharmaceutical products, taking (consuming) by the final consumer (patient) many variants of a particular good (pharmaceutical products) is unjustified and even harmful from a medical point of view. Thus, customers (patients) generally do not report additional demand for further variants of the pharmaceutical product along with an increase in income. An exception in this case may be pharmaceutical products being dietary supplements.

The negative impact of the PCI_{jt} variable can also be explained by analysing the phenomenon from the supply side. Interpretation then refers to the resources of production factors in trading countries. Rich countries with a significant GDP *per capita* have large capital resources, which allows the development of high technology industries, which undoubtedly include the pharmaceutical industry. A country's well-developed pharmaceutical industry produces, apart from relatively simple preparations, also the most modern drugs. It is therefore possible to develop exports, especially of technologically advanced drugs, to countries that do not produce them. Therefore, less affluent countries can offer simple, less technologically advanced drugs on the market, which can be produced without the need to possess or buy licenses, so these are more often generic drugs. However, it should be noted that these drugs, *i.e.* simple ones, are also produced by the pharmaceutical industry in richer countries, sometimes even cheaper due to the disclosure of the economies of scale. Therefore, there is no need to import them from other countries, and this certainly is not conducive to the development of intra-industry trade.

The confirmation of the above reasoning may be the results obtained with respect to the $DiffPCI_{jt}$ variable. The research findings show that in trade in pharmaceutical products, the relative differences in the level of economic development of Poland and its trading partners limit the development of mutual intra-industry trade. The parameter α at the $DiffPCI_{jt}$ variable was -0.0359025. Thus, the hypothesis H4 was positively verified.

The results of the study confirm that the factor that significantly and also positively affects the growth of intra-industry trade indices is the degree of trade intensity between Poland and its trading partners (the TI_{jt} variable). The intensity of trade was expressed in the share of individual trade partners in Poland's total trade in pharmaceutical products. The obtained value of the parameter α at the variable TI_{jt} informs that, on average, the increase in the intensity

of trade between countries by 1% results in an increase of intra-industry trade in relation to inter-industry trade by over 0.17%. Therefore, the research hypothesis H5 was positively verified.

The factor that significantly but at the same time negatively impacts the intensity of intra-industry trade is the degree of imbalance in trade between pharmaceutical products between Poland and the European Union. A significant impact of this variable was to be expected because in a situation when trade between two countries is not balanced, the Grubel-Lloyd index cannot reach the maximum value. The parameter α at the $TIMB_{jt}$ variable was -1.71563. The hypothesis H6 was positively verified.

General government expenditure on health in the country of the trade partner was a statistically significant factor influencing the intensity of intra-industry trade in Poland's trade in pharmaceutical products. This variable was included in the model deliberately, due to the specifics of the analysed goods. Pharmaceutical products serve to protect health and life. The study confirms that increasing government expenditure on health in the trade partner country has a positive impact on the intensity of intra-industry trade with this country (α = 0.207944). With reference to the variable $HEALTH_{jt}$, the sign which was obtained was consistent with the assumption made in the hypothesis H9, which allowed for its positive verification.

The variables related to the size of the economies of trade partners (GDP_{jt} *and* $DiffGDP_{jt}$) were proved to be statistically insignificant. Therefore, the H1 hypothesis, according to which intra-industry trade is more intense in trade with large countries that have a larger GDP, could not be verified. The H2 hypothesis, according to which the larger relative differences in the size of economies – of Poland and its trading partners, the less intense intra-industry exchange, could not be verified, either. The $DIST_j$ and BOR_j variables were also statistically insignificant. This means that the H7 hypothesis, which assumed a negative dependence between the geographical distance that separates trading partners and the intensity of their intra-industry exchange, and the H8 hypothesis, according to which the intra-industry trade develops better if the countries are close neighbours, *i.e.* they have a common border, were not verified.

Conclusions

One of the manifestations of the ongoing cooperation of countries is the intensification of mutual intra-industry trade understood as parallel import and export of similar products belonging to the same industry (commodity group). This paper identified the factors determining intra-industry trade in pharmaceutical products between Poland and European Union countries. The focus is on factors that relate to the characteristics of the trading partner economies, *i.e.* the so-called country-specific determinants. In the case of pharmaceutical products, the factors that related to the level of economic development of trading partners were statistically significant. However, the research shows that the level of economic development of EU member states (measured by the size of their GDP *per capita*) is not conducive to the development of intra-industry trade. The direction of the influence of this variable on the development of intra-industry trade obtained in this study does not confirm the predictions of the theory of intra-industry trade. However, the negative impact of this factor can be explained by the specificity of pharmaceutical products. These products do not belong to the category of goods for which customers report greater demand when their revenue increases. Since it is not medically justifiable, they do not want to buy many variants of specific pharmaceutical products, as it usually happens in the case of other goods, *e.g.* in the case of clothing.

The impact of the variable describing the relative differences in the level of economic development of Poland and its trading partners on the intensity of mutual intra-industry trade is in contrast with the predictions of the theory. The research shows that the degree of the intensity of trade in pharmaceutical products between Poland and its trading partners also has an important and positive impact on the development of intra-industry trade. On the other hand, however, the degree of imbalance in trade in pharmaceutical products between Poland and EU countries has a negative impact. The obtained results of the research also confirm that an important factor that positively influences the development of intra-industry trade in pharmaceutical products is the size of general government expenditure on health in the country of the trade partner.The variables related to the size of the trading partners'

economies, the geographical distance between Poland and its trading partners, and the fact that Poland has a common border with some trade partners turned out to be statistically non-significant factors.

The model of intra-industry trade constructed in this study can be used to identify countries (within the European Union) which have potential for the development of trade in the field of pharmaceutical products. In this context, particular attention should be paid to those trading partners with whom trade in pharmaceuticals is relatively large and intra-trade indicators remain at a low level.

This study is part of the research stream that has been undertaken in world science. However, it certainly does not exhaust the problem. In terms of the presented issue, it is worth examining the impact of identified determinants separately on vertical intra-industry trade and separately on horizontal intra-industry trade. Particularly interesting in this context could also be in-depth analyses of the impact of foreign direct investment (broken down into the vertical and horizontal forms) on intra-industry trade.

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Abstract

COUNTRY-SPECIFIC DETERMINANTS OF INTRA-INDUSTRY TRADE IN PHARMACEUTICALS: THE CASE OF POLAND AND ITS EUROPEAN UNION PARTNERS

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Trade cooperation between European Union countries is based mainly on intra-industry trade, consisting in the simultaneous import and export of similar products belonging to the same industry (commodity group).

The present study has investigated the country-specific determinants of intra-industry trade between Poland and its European Union trading partners in pharmaceutical products during the time period 2004-2016. To this end, an econometric model for panel data was constructed.

The research shows that the intensity of intra-industry trade in Poland-EU trade in pharmaceuticals is determined by several key factors. The intensity of trade with particular EU countries and the size of general government expenditure on health in the countries of trading partners have a positive impact on the development of this type of exchange. A factor that significantly and simultaneously affects the intensity of intra-industry trade is the degree of imbalance in the trade balance in pharmaceutical products with individual trading partners.

The development of intra-industry trade is also limited by factors related to the level of economic development of trading partners. The study confirmed that the greater the differences in the level of GDP per capita between Poland and the trading partner, the less intense intra-industry trade. Also, the growth of GDP per capita in the countries of trade partners is not conducive to the development of intra-industry trade in Poland's trade in pharmaceuticals. The direction of the impact of this variable (GDP per capita) on the intensity of two-way trade obtained in this study does not confirm the predictions of the theory of intra-industry trade. However, the negative impact of this factor can be explained by the specificity of pharmaceutical products that are purchased by consumers generally only in justified situations resulting from health or life protection.

Key Words: *Intra-industry trade, pharmaceutical products, Poland, European Union.*

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